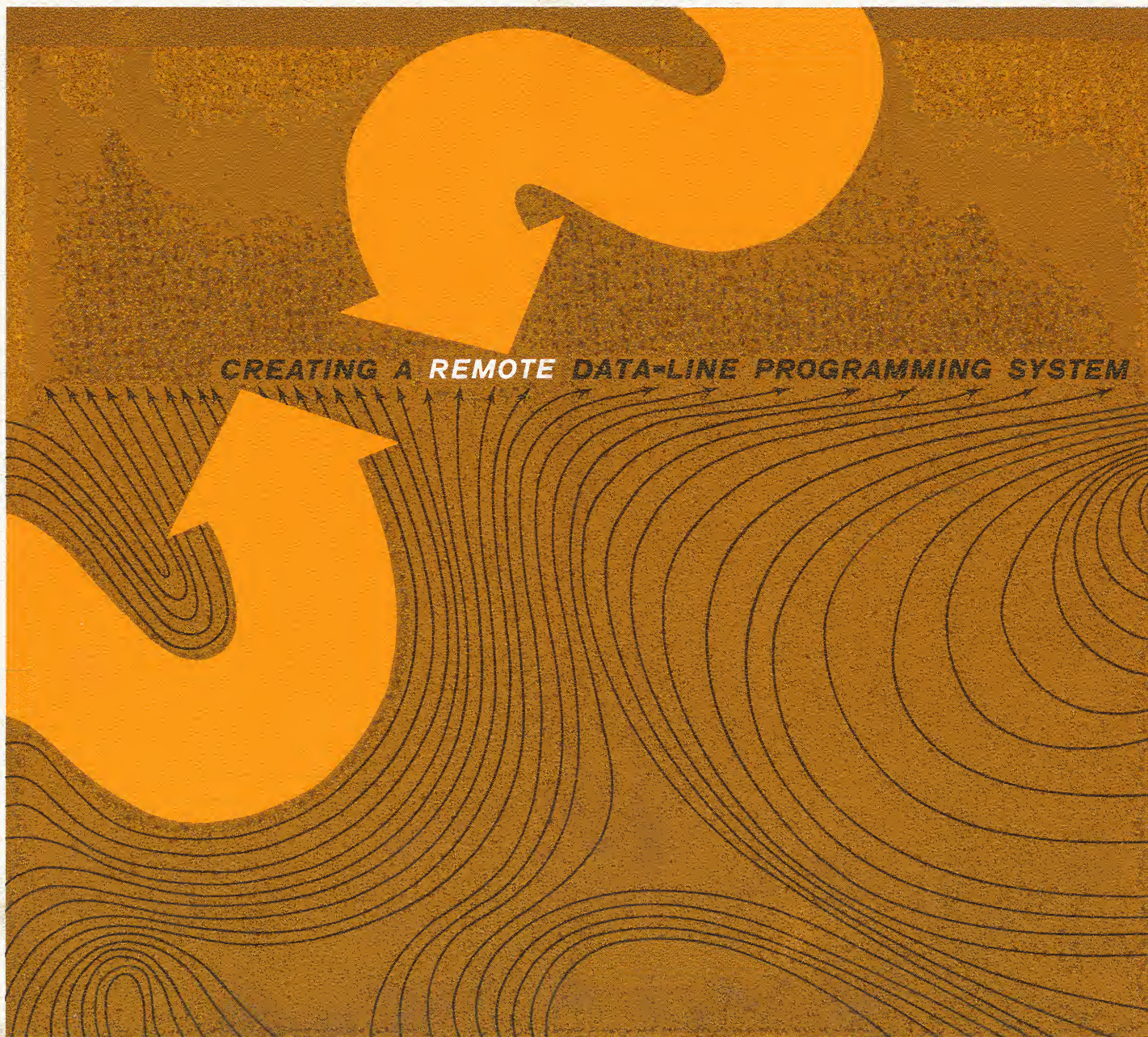


CSC REPORT

CREATING A REMOTE DATA-LINE PROGRAMMING SYSTEM





A computer specialist with over 12 years in the information sciences, Dale Hanks joined CSC in 1959 and was formerly with North American Aviation for seven years. Mr. Hanks has supervised the design of complex operating systems for real-time computers, the development of specialized compilers, and CSC's data communications system.

CREATING A REMOTE DATA-LINE PROGRAMMING SYSTEM

By Dale Hanks, Manager, CSC Utility Systems

CSC recently created a data-line programming system which enables users at remote locations to take advantage of CSC's large scale Univac 1107 computer and its advanced software on an "as-needed" basis. This remote data-line control system ties a user's self-contained card processor (*i.e.*, Univac 1004 or IBM 1974) to the Monitor System of CSC's Los Angeles-based 1107. The Monitor System, in turn, provides access to FORTRAN IV and COBOL processors, an advanced SLEUTH II assembler, a large scale Linear Programming system, and a variety of mathematical and utility routines.

The Monitor System is a multiprocessor executive routine, permitting simultaneous use of associated readers, printers, and punches, as well as central processor operation. In effect, the 1107 is able to print one program, execute another, and read a third, all in the same time interval. It accomplishes this by use of a "symbiont" (parasitic) method of operation.

The design of the remote, on-line computing system posed a number of problems not normally encountered by the systems programmer. In order to give the satellite stations full use of all the software available on the 1107, the system had to be developed to provide these remote processors with the ability to run *any* program directly on the 1107; any card deck set up for a run on the 1107 may be taken to a satellite station and read into its card reader with assurance of successful remote operation.

The operator of the satellite processor also had to be given control over the transmission of data to and from his station in order to allow for such contingencies as changing of printed forms, reloading the card reader, calling for the output to be printed at another station, or stopping the printing of a job on the basis of early evaluation of results.

Other objectives of the system were to allow data-line transmissions to take place without slowing the 1107 in the processing

of other jobs, to provide the ability to check for and automatically recover from errors in transmission, to keep the operator actions as simple as possible, and to limit connections to one line for both transmission of programs and receipt of results.

Some of the specific problems encountered by the system designers included the following:

1. The character sets on the remote processors are different from the character set of the 1107, requiring a character-by-character conversion.
2. The rate at which characters can be transmitted over an ordinary telephone line is 285 characters per second, which is slower than the information rate possible when reading cards or printing. To counteract this, it was desirable to suppress transmission of any unnecessary information (such as blank fields) on the card or printed line.
3. The transmission must be interrupted periodically to allow a reply indicating correct or incorrect receipt. Because of the nature of the transmission equipment, each time the direction of transmission is changed, 150 milliseconds are lost. It was therefore desirable to keep the messages as long as could be conveniently handled in the input/output buffers at both ends.
4. The operators of the satellite station and the 1107 are not able to talk to each other while the transmission is taking place, since the telephone line is already in use for data transmission. To counteract this, the satellite operator had to be able to control the operation at his end, and the 1107 operator had to be informed of what he is doing.
5. The output of a run may need to be saved for transmission at a later time, or to a different satellite. Provision had to be made to preserve it until it has been successfully transmitted to all its destinations.
6. Errors on the part of the operators at either end had to be

expected; the system had to be able to recover when this happens.

7. The satellite processor sends a special message when it has waited 20 seconds and has not received a message. The system had to be designed to accept this message and act upon it.

8. A message sent to the satellite during the same time it is reading a card or printing a line will be incorrectly transmitted. The system had to compensate for these timing problems.

9. Occasionally a message will be cut off before it has reached the end-of-message marker. A noisy or badly connected telephone line may do this. The system had to recognize this situation and be able to recover from it.

10. Since the running of a job is usually faster than the transmission of the input for the job, it was desirable for the system to wait until all the input has been received before the run starts.

11. Since output is normally available before a job is complete, output was to be started back as soon as the job starts running.

12. Sometimes the job will not produce output as fast as it is being transmitted. The system had to be able to handle this situation.

13. The satellite station needs to know how much output it is to expect. This information had to be given early in the transmission in order to be useful.

14. Since there are occasional troubles with telephone connections, the output had to be preserved at the 1107 until it has all been successfully transmitted.

15. The satellite station operator had to be sent accounting information for his own record-keeping.

In addition, the checkout of this system presented several problems not encountered in the checkout of compilers and other programs. First, not only was it necessary to check out the symbionts in the 1107 computer, but also the board wiring of the Univac 1004, switching of the telephone circuits, and the hardware itself. Bugs were traced and eliminated in each instance. Second, it was necessary on the later checkout runs to schedule the 1107, two satellite stations, and a long-distance telephone line, and have them all available at the same time — not an easy task. This was necessary because the symbionts had to be checked out to operate with at least two stations simultaneously.

The nature of the transmission medium was also a consideration in the design of the system. Each terminal of a data-line communication system is equipped with a Bell System 201A or B Data Set. This set takes the bits sent to it from either the 1107 or the satellite computer and breaks them into units of two bits each. The data set continuously transmits a carrier of 1750 cps, but once each millisecond this carrier is shifted 45°, 135°, 225°, or 315°, in phase. Thus, one of four different states can be represented each millisecond. At CSC, the carrier shift represents two bits (00, 01, 10, or 11) from the transmitted character. Thus, the transmission is accomplished over ordinary voice telephone lines at 2000 bits per second (2400 bits/sec for 201B). At the receiving end the signal is split through two separate channels, one of which has a one-millisecond delay. The signals from the two channels are compared, effectively comparing the present signal with the previous one-millisecond signal. With this information the data set reconstructs the message at the other end. For each character, six bits plus a parity-check bit are sent over the telephone line. So that noise on the telephone line will not be read as data, each message begins with a pair of sync characters. The data sets can transmit in one direction at a time, but can switch directions in 150 milliseconds. This mode of transmission is called half-duplex.

In meeting these objectives, the following system evolved:

1. After initial hook-up, both the 1107 and the satellite station transmit "standby" messages periodically so that both terminals know that a good telephone connection exists.

2. The satellite operator, by pressing switches on his processor, can cause cards to be read and transmitted to the 1107.

3. The card images are broken into short (10-character) fields. Any field which is completely blank is not transmitted. (Similarly, printing and punching are accomplished in 12-character fields.)

4. The 1107, when it receives a "long" message, will switch to the "card read" routine to process the input cards, placing them in drum storage just as if they had been read from the 1107's card reader. (All messages other than card reader messages are "short" messages consisting of only a few identifying characters.)

5. When output is available, the satellite is so informed. When it has acknowledged and switched to its print-punch routine, the 1107 sends "print" or "punch" messages out to it.

6. The satellite operator can at any time, by pressing his switches, cause a message for special action to be transmitted to the 1107. This message is interpreted at the 1107 and will cause special actions such as delay, stop-run, etc.

7. Each message sent is acknowledged by a short message as good or bad. If it is bad, the message is automatically repeated, and marked as a repeated message.

To maintain efficient use of the computer, programs which receive and prepare data-line messages for transmission operate only for short intervals just after a message is received and just before a message is sent. In the interim, the user's program is given control of the 1107 and, simultaneously, the data-line message is read into or out of the 1107 core memory. As the data are received, they are buffered onto a large-capacity drum in order to provide backup. The same procedure is followed for output.

The programs which accomplish this are called symbionts because they cooperate with the external devices. These symbionts have special problems because they must operate for only short intervals and then give up control while data are being transmitted into or out of the message buffers. When control is regained it may be because data transfer has been completed for another of the several data-line channels. The symbionts had to be constructed in such a way that they recognize the channel on which they are operating at any given time. In particular, the 1107 system dispatcher had to be modified so that when control is relinquished by a symbiont, information is retained to be passed back to the symbiont when it is again activated. This modification indicates to the symbiont the channel upon which it is working.

The remote, on-line CSC system has been in successful operation for several months. A number of CSC Service Bureau clients have installed satellite processors and have successfully run assemblies and FORTRAN IV and COBOL compilations for a variety of scientific and commercial problems. They have checked out their programs on the remote processor, obtaining memory dumps as needed via the transmission link. Some users with extensive programs involving extremely large program decks have had them written onto magnetic tape, delivered to CSC for storage, and mounted by CSC computer operators upon instructions transmitted from their remote stations. One special application involved the punching of binary cards in 8-level paper-tape-character format for use in APT numerical control.

An information manual describing the remote data-line control system is available to prospective clients from CSC's Service Bureau Division.

CSC WINS \$3.5-MILLION IN SECOND QUARTER CONTRACTS

CSC has been awarded new government and commercial contracts during the past 90 days estimated to provide revenue in excess of \$3.5-million.

Approximately 70 percent of this new business volume is under government contracts and 30 percent in the commercial field. New customers include the Department of Defense, U. S. Army, NASA's Goddard Space Flight Center, Signal Oil and Gas Co., and Rohr Corporation. New contracts and extensions on continuing efforts have been received from clients such as IBM, Jet Propulsion Laboratory, and Edgerton, Germeshausen and Grier.

Under these recent awards, CSC's programming and analysis services have been provided in applications ranging from the design and development of a comprehensive management reporting system to orbital mechanics, data reduction and analysis, mechanical and physical analysis, systems analysis, systems programming, operational analysis, and documentation.

NEW CSC PERSONNEL BOOST STAFF OVER 250

Ten staff members with more than 55 years of experience joined CSC last month, bringing the company's staff total over 250.

Marvin L. Pulliam and Raymond A. Gerber were appointed senior members of the technical staff. Mr. Pulliam is assigned to the Operational Systems Department and has over eight years experience at System Development Corporation where he supervised the SAGE Operational Group and was responsible for program design, coding, testing, and maintenance of design improvements required in the operational program.

Mr. Gerber, a veteran of over 11 years in the computing field, was formerly with Aerojet General Corporation for five years as Manager, Engineering and Test Programming Department. Mr. Gerber was responsible for scientific, engineering, and test analysis programs; his experience extends over such applications as trajectory and flight simulation, heat transfer, rocket motor ballistics, and numerous general engineering problems.

In Commercial Applications, new members of the technical staff include Jerry Schwartz, formerly with Simon Levi; Robert MacGuire and Mark Raphael, Hughes Aircraft; and Edward Bauer of North American Aviation.

The Houston Division added Ernest Barnes, formerly with CDC; Gilbert Silverman, of ITT; Donald Spears, of Home Comfort Products; and Tom Moore, Tenneco Oil.

MAJOR NASA CONTRACT AWARDED TO CSC

CSC has been awarded a major contract for computer programming services by the National Aeronautics and Space Administration's Goddard Space Flight Center, Greenbelt, Maryland.

The NASA contract covers a three-year period during which CSC will provide such services as mathematical and physical analysis, systems analysis, scientific programming, operational analysis, and documentation.

CSC specialists assigned to the company's Washington Division will be responsible for the design, development, coding, testing, and documentation of computer programs for Goddard. In addition, CSC will provide computer operational analyses in support of GSFC projects in scientific communications and meteorological applications in the aerospace field.



CSC executives review management and programming flow requirements for a large scale command and control system. (Left to Right) Marvin Pulliam, Senior Specialist; Dr. Stewart Fliege, Manager, Operational Systems; and Verlyn Unruh, Senior Specialist. Capabilities of CSC in operational systems include staff experience on SAGE, BUIC, SATIN, SFOF, DASA, DODDAC, NTDS, and SAC control systems.

CSC MANAGERS ADDRESS VARIED PROFESSIONAL GROUPS

From computer users to accountant societies, CSC managers and staff members have been active in accepting a variety of speaking engagements throughout the country, as well as in Canada.

At the annual meeting of Guide Users in Toronto this month, Robert Bohrer, Manager of CSC's Commercial Applications, discussed "Estimating and Control of Time and Cost Factors in System Development and Programming."

CSC Service Bureau Manager Dan Mason addressed the Arrowhead Chapter of ACM last month on "Management of a Large Scale Computing Center."

To five CPA societies in Southern California and in various meetings of over 400 accountants in New York and San Francisco, Alan Stern of the COMPUTAX project described CSC's new service of preparing tax returns by computer.

Harold Bergstein, Director of Public Relations, was an invited speaker at the Management Information Processing Association in September and at the San Fernando Valley Chapter of the ACM this month. His subject: "Manpower Effects of Computers in Business and Science."

3RD QUARTERLY DIVIDEND DECLARED BY DIRECTORS

CSC's Board of Directors last month announced the company's third cash dividend, three cents per share, declared for the quarter ending September 30, 1964. Date of record is October 15 and payment date, October 30.

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